CLAIMS

1. A method for representing sequential motion patterns, the method comprising:

converting video frames into a sequence of energy redistribution measurements; and

applying one or more motion filters to the ER measurements to generate a number of temporal sequences of motion patterns, the motion patterns being in a spatio-temporal data format, the number being a function of how many motion filters were applied to the ER measurements.

2. A method as recited in claim 1, wherein each motion filter of the one or more motion filters is a weighting matrix of values designed to identify a particular type of motion.

3. A method as recited in claim 1, wherein converting further comprises determining a change in energy distribution between multiple ones of the video frames via respective motion vector fields (MVFs), the video frames being within a sliding window of video frames.

4. A method as recited in claim 1, wherein converting further comprises configuring a width and/or frame frequency sampling parameter associated with the sliding window to adjust computational complexity and/or performance of the method.

5. A method as recited in claim 1, wherein energy at block (x, y) of a frame of the video sequence is denoted by $E_{x,y}$, and wherein converting further comprises determining a change in energy distribution E' between the block (x, y) and block (i, j) in a previous frame of the video sequence as a function of:

$$E'_{x,y} = \frac{\sum_{i,j} \left(overlapS_{i,j,x,y} \times E_{i,j} \right)}{W_b^2}, \quad i, j \in [1, W_b]; \text{ and}$$

wherein *overlap* $S_{i,j,x,y}$ denotes an overlap portion of a rectangular region corresponding to block (i, j) and block (x, y), and W_b represents block size.

6. A method as recited in claim 5, wherein converting further comprises, if a block is not in a frame boundary, placing the block within the frame boundary by decreasing a magnitude of a corresponding motion vector field.

7. A method as recited in claim 5, wherein each motion filter is a respective weighting matrix of values, elements of each weighting matrix being denoted as $w_{i,i,}$ and wherein applying further comprises calculating an ER measurement from respective ones of the video frames such that resulting temporal energy responses E_R are determined according to:

$$E_R = \sum_{i,j} E_{i,j} \times w_{i,j} \quad i,j \in [1, W_b]; \text{ and}$$

wherein, $E_{i,j}$ denotes the energy distributed in each block (i,j), and W_b represents block size.

8. A method as recited in claim 1, further comprising:

for each motion filter, identifying a respective mean energy value of a temporal sequence associated with the motion filter; and

combining respective mean energy values to create an n-dimensional observation vector; the n-dimensional observation vector representing ER responses to each of the motion filters and original input and difference temporal sequences.

9. A method as recited in claim 8, further comprising analyzing the n-dimensional observation vector with a statistical sequential pattern analysis tool to map the motion patterns to semantic events associated with the video frames.

10. A method as recited in claim 9, wherein statistical sequential pattern analysis tool is based on Hidden Markov Models.

11. A computer-readable medium comprising computer-program instructions executable by a processor for performing operations as recited in the method of claim 1.

12. A computing device comprising a processor coupled to a memory, the memory comprising computer-program instructions executable by the processor for performing operations as recited in the method of claim 1.

13. A computer-readable medium comprising computer-program instructions for representing sequential motion patterns, the computer-program instructions being executable by a processor, the computer-program instructions comprising instructions for:

generating one or more motion filters according to respective ones of primary motions in a video sequence, each of the motion filters being responsive to a particular one dominant motion of the primary motions;

calculating energy redistribution measurements between respective frames of the video sequence, the respective frames being determined by a sliding window of video frames of the video sequence;

converting the energy redistribution measurements into temporal sequences showing distinct motion patterns, each temporal sequence being generated responsive to application of a particular one of the motion filters to the energy redistribution measurements; and

wherein the temporal sequences represent high-level spatio-temporal motion patterns of the video sequence.

14. A computer-readable medium as recited in claim 13, wherein each motion filter is a weighting matrix of values designed to identify a particular type of motion.

15. A computer-readable medium as recited in claim 13, wherein energy at block (x, y) of a frame of the video sequence is denoted by $E_{x,y}$, and wherein calculating further comprises determining a change in energy distribution E' between the block (x, y) and block (i, j) in a previous frame of the video sequence as a function of:

$$E'_{x,y} = \frac{\sum_{i,j}\left(overlapS_{i,j,x,y} \times E_{i,j}\right)}{W_b^2}, \quad i, j \in [1, W_b]; \text{ and}$$

wherein $overlapS_{i,j,x,y}$ represents an overlap portion of a rectangular region corresponding to block (i, j) and block (x, y), and W_b represents block size.

16. A computer-readable medium as recited in claim 13, wherein converting further comprises:

determining that a block is not in a frame boundary associated with frames of the video sequence; and

responsive to the determining, placing the block within the frame boundary by decreasing a magnitude of a corresponding motion vector field.

17. A computer-readable medium as recited in claim 13, wherein each motion filter is a respective weighting matrix of values, elements of each weighting matrix being denoted as $w_{i,i}$, and wherein applying further comprises calculating an ER measurement from respective ones of the video frames such that resulting temporal energy responses E_R are determined according to:

$$E_R = \sum_{i,j} E_{i,j} \times w_{i,j} \quad i, j \in [1, W_b]; \text{ and}$$

wherein, $E_{i,j}$ denotes the energy distributed in each block (i,j), and W_b represents block size.

18. A computer-readable medium as recited in claim 13, wherein the computer-program instructions further comprise instructions for:

identifying, for each motion filter, a respective mean energy value of a sequence of the temporal sequences associated with the motion filter;

combining respective mean energy values to create an n-dimensional observation vector; the n-dimensional observation vector representing energy redistribution responses to each of the motion filters and original input and difference temporal sequences.

19. A computer-readable medium as recited in claim 18, wherein the computer-program instructions further comprise instructions for analyzing the n-dimensional observation vector with a statistical sequential pattern analysis tool to map the motion patterns to semantic events associated with the video frames.

20. A computer-readable medium as recited in claim 19, wherein statistical sequential pattern analysis tool is based on Hidden Markov Models.

21. A computing device comprising a processor coupled to a computer-program medium as recited in claim 13.

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22. A computing device comprising a processor coupled to a memory, the memory comprising computer-program instructions executable by the processor for:

deriving motion vector fields (MVFs) between frames of a video sequence as a function of a sliding window comprising a configurable number of the frames, each MVF representing an energy distribution between a particular block in a first frame of the frames and a different block in a second frame of the frames that is adjacent to the first frame;

modifying content of the sliding window to include a new frame of the frames;

responsive to modifying the content, updating, the represented energy distributions for each block, the updating being based on an overlap portion of the block and a previous block of a previous frame of the frames; and

motion filtering the energy distributions to sequentially represent one or more motion types presented by the video sequence over time, the one or more motion types identifying one or more sequential motion patterns of the video sequence.

23. A computing device as recited in claim 22, wherein the computer-program instructions for updating further comprise instructions for:

representing energy at block (x, y) of the current frame as $E_{x,y}$; and

wherein updating further comprises determining a change in energy distribution E' between the block (x, y) and block (i, j) in the previous frame as a function of:

$$E'_{x,y} = \frac{\sum_{i,j}\left(overlapS_{i,j,x,y} \times E_{i,j}\right)}{W_b^2}, \quad i,j \in [1, W_b]; \text{ and}$$

wherein *overlap* $S_{i,j,x,y}$ represents the overlap portion, the overlap portion being a rectangular region corresponding to block (i, j) and block (x, y), W_b representing block size.

24. A computing device as recited in claim 22, wherein the computer-program instructions for deriving and/or updating further comprise instructions for:

determining that a block of the frames is not in a frame boundary; and

responsive to the determining, placing the block within the frame boundary by decreasing a magnitude of a corresponding motion vector field.

25. A computing device as recited in claim 22, wherein the computer-program instructions for motion filtering further comprise instructions for applying a weighting matrix of values designed to identify a particular type of motion to the energy redistributions.

26. A computing device as recited in claim 22, wherein the computer-program instructions for motion filtering further comprises instructions for applying a motion filter designed to identify a particular type of motion to the energy redistributions, each motion filter being a respective weighting matrix of values, elements of each weighting matrix being denoted as $w_{i,i,;}$ the applying comprising calculating a respective energy redistribution measurement from respective ones of the frames such that resulting temporal energy responses E_R are determined according to:

$$E_R = \sum_{i,j} E_{i,j} \times w_{i,j} \quad i,j \in [1, W_b]; \text{ and}$$

wherein, $E_{i,j}$ denotes the energy distributed in each block (i,j), and W_b represents block size.

27. A computing device as recited in claim 22, wherein the computer-program instructions for motion filtering further comprise instructions for:

identifying, for each motion filter of one or more motion filters, a respective mean energy value of a sequence of the temporal sequences associated with the motion filter;

combining respective mean energy values to create an n-dimensional observation vector; the n-dimensional observation vector representing energy redistribution responses to each of the motion filters and original input and difference temporal sequences.

28. A computing device as recited in claim 27, wherein the computer-program instructions further comprise instructions for analyzing the n-dimensional observation vector with a statistical sequential pattern analysis tool to map the motion patterns to semantic events associated with the video frames.

29. A computing device as recited in claim 28, wherein statistical sequential pattern analysis tool is based on Hidden Markov Models.

30. A computing device for representing sequential motion patterns, the computing device comprising:

means for converting video frames into a sequence of energy redistribution measurements; and

means for applying one or more motion filters to the ER measurements to generate a number of temporal sequences of motion patterns, the motion patterns being in a spatio-temporal data format, the number being a function of how many motion filters were applied to the ER measurements.

31. A computing device as recited in claim 30, wherein the means for converting further comprises means for determining a change in energy distribution between multiple ones of the video frames via respective motion vector fields (MVFs).

32. A computing device as recited in claim 30, further comprising:

for each motion filter, means for identifying a respective mean energy value of a temporal sequence associated with the motion filter; and

means for combining respective mean energy values to create an n-dimensional observation vector; the n-dimensional observation vector representing ER responses to each of the motion filters and original input and difference temporal sequences.

33. A computing device as recited in claim 30, further comprising means for analyzing the n-dimensional observation vector with a statistical sequential pattern analysis tool to map the motion patterns to semantic events associated with the video frames.